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SOVIET WORK ON HYDROTHERMIC METHOD FOR CONVERSION OF NATURAL PHOSPHATES INTO FERTILIZERS

S. I. Vol'fkovich

[Comment: The text of the following report summarizes a paper presented by Academician S. I. Vol'fkovich on 21 October 1954 at a general meeting of the Department of Chemical Sciences, Academy of Sciences USSR. The process for the production of phosphate fertilizers which was described by Vol'fkovich is of importance because it does not require the use of any acid. Thus, the use of sulfuric acid needed the the production of ordinary superphosphate, or the use of sulfuric, nitric, or hydrochloric acid needed in the production of double superphosphate (cf A. V. Sokolov, Rol' Khimii v Sel'skom Khozyaystve, -- The Role of Chemistry in Agriculture --, Moscow, 1954, p 15), will be unnecessary if the new process supplants old procedures for the production of superphosphate.

Since the production of phosphate fertilizers is large in volume, large quantities of acid (particularly sulfuric acid) will be released for other purposes as a result of the introduction of the new process, thus increasing the potential for the production of chemicals other than fertilizers. The extent to which the new process will be introduced presumably depends on the availability of a supply of suitable fuel, which, according to Vol'fkovich, should be liquid fuel or gas. It is to be assumed that a sufficiently high temperature cannot be achieved with coal under ordinary conditions in equipment which is not very elaborate and expensive.]

The hydrothermic process consists in the treatment of fluoroapatite with water vapor in the presence of silicon dioxide or alumosilicates at a temperature of approximately 1400-1450 degrees centigrade.

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The process comprises two stages. The first stage involves elimination of fluorine from the crystal lattice of fluoroapatite and its simultaneous replacement with hydroxyl ions, so that hydroxyl-apatite is formed. In the second stage, decomposition of hydroxyl-apatite by heat takes place. The hydroxyl-apatite is decomposed into the alpha-modification of tricalcium-phosphate and tetracalciumphosphate. As a result of this process, the initial apatite, which is insoluble both in water and a solution of citric acid, is transformed into compounds which are soluble in a 2% solution of citric acid (measurement of the solubility in citric acid is the conventional way of testing the assimilability of phosphates by plants).

When apatite mixed with silicon dioxide is treated with water vapor, silicophosphates of calcium are formed, which are readily soluble in citric acid.

Investigations which had been carried out indicated the advisability of applying technically the process of the hydrothermic conversion of natural phosphates. The mechanism of the process was studied on synthetic fluoro-apatite, synthetic hydroxyl-apatite, and Khibinsk apatite concentrate which contained nephelin. It has been established that it is advisable to carry out the first stage of the process (elimination of fluorine) with a considerable excess of water vapor and that it is possible to conduct the second stage in the absence of water vapor, or in the presence of only a small amount of it.

Experiments on the application of silicon dioxide have shown that irrespective of the quantity of this compound which is added to the charge (0.25-10% were added), the identical degree of elimination of fluorine and of conversion of the phosphate into a citric-acid-soluble form is achieved. This conversion amounts to 90% or more.

With 2-5% of silicon dioxide added to a charge consisting of apatite concentrate, it is possible to obtain a product containing up to 24-38% of citric-acid-soluble P_2O_5 and no more than 0.1% of fluorine. In other words, a fertilizer is obtained which is twice as highly concentrated as Thomas slag. Because of its very low fluorine content and the absence of other harmful ingredients in it, the new type of phosphate with a reduced fluorine content may be used not only as a concentrated fertilizer but also as an animal feed ingredient.

The process which has been subjected to investigation requires neither the acids necessary for the production of the majority of phosphate fertilizers, nor the alkalis needed in the production of thermal phosphates, nor the large amounts of electrical power which have to be expended in processes based on the distillation of phosphorus. The high temperature which is needed and the generation of water vapor are achieved by burning liquid fuel or gas.

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